RAYTHEON COMPANY
Research Division
131 Spring Street
Lexington, MA 02173

RF VACUUM MICROELECTRONICS

8th Quarterly Progress Report
September to November 1993

RAY/RD/S-4955

7 January 1994

Contract No. MDA972-91-C-0032

Sponsored by

Advanced Research Project Agency
Defense Sciences Office

1.0 EXECUTIVE SUMMARY

Third iteration masks designed, layed out and received. Processing was started.

New mounting alumina received.

Third mounting vacuum flange designed and ordered.

On internal funds, cathodes from LETI procured and evaluated. These results will give direction to this contract.

2.0 MILESTONES STATUS

	Completion Date Original	Act/Est
1. Utilize features of new evaporator to improve moly tips	4/94	4/94
2. Capacitance issue	9/93	1/94
3. Lower work function	3/94	3/94
4. High frequency design/fab #3	1/94	4/94
5. Source pull measurements	3/94	4/94
6. Load pull measurements	5/94	5/94

3.0 TECHNICAL PROGRESS

On an internal Raytheon program, FEA cathodes for display were procured from LETI in Grenoble, France. These are the same cathodes that are used in the only working FED display. There are two properties of these cathodes we plan to try to incorporate into our FEA cathodes for this contract. First, a distribution of holes sizes was used. Our next mask design has some of the cathodes with a mix of 1-, 1.1-, and 1.2-micron diameter holes. Our conventional approach was to have all the holes at the nominal size of 1 micron. The second property was a series resistor. With the series resistor, the cathodes were much less prone to blown tips and could withstand arcs without large surface destruction. Since the current requirements for the displays is two orders of magnitude less than the microwave application, the resistor must be two orders of magnitude smaller. There will be a trade-off in terms of resistor value, maximum current, and reduced RF gain.

The cathodes are routinely measured in pulse mode. In our measurement set-up, the RF can also be observed directly on a high speed digitizing scope. However, the pulser and the RF source are not phase locked so only the RF envelope and not the RF wave can be observed. The electronics are being modified to phase lock the low frequency pulser to the RF source so the detailed RF pulsed waveform can be observed.

The third mask design was completed and masks ordered and received. Wafer fab has started with these masks. These masks have been optimized for the mixed stepper/contact mask process we are now using. Also, the masks for the resistive layer have been included. Two of the cathode designs that were not practical were eliminated giving twice as many of the two good designs.

The cathodes have in the past been unpassivated, that is the gate leads to the tips are not covered. While testing the LETI cathodes in a high voltage (10 kV), low current per tip

environment, emission from the edges of the gate leads was observed. The RF testing is in a much lower voltage (500 V) albeit much higher current per tip regime. Spurious gate emission which could lead to catastrophic failure is much harder to detect. We plan to passivate the leads to eliminate this stray current.

The new alumina design that was described in the previous report was received.

A third mounting flange was ordered. This will allow for two to be mounted in the test chamber and the third to be used for cold testing.

4.0 FISCAL STATUS

CONTRACT NO: MDA972-91-C-0032
CONTR. TITLE: RF VACUUM MICROELECTRONICS-OPTION
CONTRACTOR: RAYTHEON CO., RESEARCH DIV.

DATE PREPARED: 21-Dec-93
REPORT PERIOD: 11/01/93-11/28/93

FUNDS AND MANHOUR EXPENDITURE REPORT

CONTRACT VALUE:	$467,710
CURRENT FUNDING (sell):	$467,710
NEG. FEE RATE:	0.0%
% FUNDING SPENT & COMMITTED:	40.4%

	CONTRACT VALUE	REPORTING MO. EXPEN-DITURES	CUMULATIVE EXPEND. TO DATE	% $ VALUE	COST TO COMPLETE ESTIMATE	LATEST COST ESTIMATE	PREVIOUS COST ESTIMATE
A	B	C	D	E	F	G	H
TOTAL PRIME LABOR HOURS	4,794	208	1,844		3,160	4,794	0
TOTAL PRIME LABOR	$133,120	$6,089	$47,418		$85,702	$133,120	$0
LABOR OVERHEAD	$228,935	$13,962	$86,206		$142,729	$228,935	$0
TOTAL LABOR & OVERHEAD	$362,055	$20,051	$133,624		$228,431	$362,055	$0
MATERIALS	$29,000	$60	$6,041		$22,959	$29,000	$0
ODC	$0	$110	$413		($413)	$0	$0
IWR	$0	$0	$0		$0	$0	$0
PRODUCT COST	$391,055	$20,221	$140,078		$250,977	$391,055	$0
G & A	$62,031	$3,020	$21,146		$40,885	$62,031	$0
COM	$14,624	$618	$4,367		$10,257	$14,624	$0
TOTAL COST LEVEL	$467,710	$23,859	$165,591		$302,119	$467,710	$0
FEE	$0	$0	$0		$0	$0	$0
TOTAL CONTRACT PRICE	$467,710	$23,859	$165,591	35.40%	$302,119	$467,710	$0
OUTSTANDING COMMIT.		$23,280	$23,280				
TOTAL COMMIT & EXPEND.	$467,710	$47,139	$188,871	40.38%		$467,710	$0

EXPENDITURES THIS QUARTER:	$112,736
TOTAL EXPENDITURES TO DATE:	$165,591
PROJECTED EXPENDITURES:	
12/93 - 02/94:	$216,109
03/94 - 05/94:	$80,000
06/94 - 08/94:	$6,010
TOTAL EXPENDITURES TO DATE:	$165,591
PROJECTED ADDITIONAL EXPENDITURES:	$302,119
1) IS CURRENT FUNDING SUFFICIENT (Y/N):	YES
2) WHAT IS FY93's FUNDING REQUIREMENT?:	$467,710
3) IS ALL DATA CROSS REFERENCED?:	YES

5.0 PROBLEM AREAS

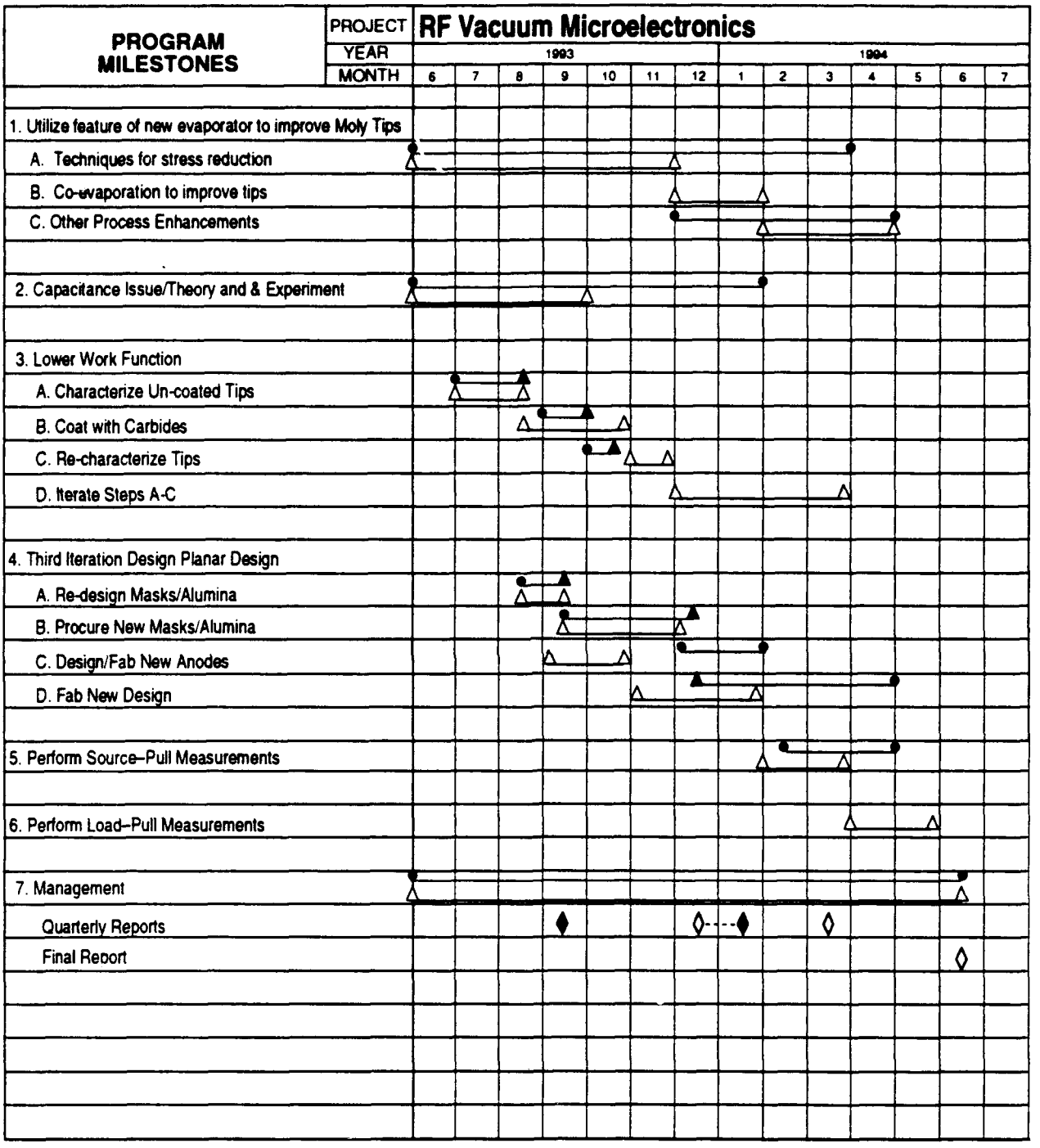
There is a yield problem in making tips on sapphire as opposed to silicon substrates. It appears that the deposition of the parting layers and moly for the tips causes the underlying gate moly layer to peel away from the oxide. This problem does not occur on silicon substrates. We are performing experiments to try to solve this problem.

Due to heavy use of the test chamber by the internal display effort, there has been some schedule slippage. This will be made up in the next six months.

6.0 VISITS AND TECHNICAL PRESENTATIONS

None

PBN-93-448A


PROGRAM MILESTONES
PROJECT
RF Vacuum Microelectronics
YEAR
1993
1994
MONTH
6 7 8 9 10 11 12 1 2 3 4 5 6 7
1. Utilize feature of new evaporator to improve Moly Tips
A. Techniques for stress reduction
B. Co-evaporation to improve tips
C. Other Process Enhancements
2. Capacitance Issue/Theory and & Experiment
3. Lower Work Function
A. Characterize Un-coated Tips
B. Coat with Carbides
C. Re-characterize Tips
D. Iterate Steps A-C
4. Third Iteration Design Planar Design
A. Re-design Masks/Alumina
B. Procure New Masks/Alumina
C. Design/Fab New Anodes
D. Fab New Design
5. Perform Source–Pull Measurements
6. Perform Load–Pull Measurements
7. Management
Quarterly Reports
Final Report
Lower Line Indicates: Planned Perod Of Performance
Upper Line Indicates: Forecast Different From Plan
Actual Start, Forecast Completion
Actual Start & Actual Completion
Planned Expenditures
Actual Expenditures